Journal of Environmental Health and Sustainable Development

Microbial Fuel Cell: A New Alternative Technology to Generate Electricity from Organic Matter

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A R T I C L E I N F O

LETTER TO EDITOR

Article History:
Received: 25 December 2016
Accepted: 29 February 2017

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Citation: Gholizadeh A. **Microbial Fuel Cell: A New Alternative Technology to Generate Electricity from Organic Matter**. J Environ Health Sustain Dev. 2017; 2(1): 185-6.

Currently, the greatest amount of energy consumption in the world is shared by fossil and nuclear fuels, resulting in severe environmental impacts such as: natural resource exhaustion, air and water pollution, soil contamination, and climate change [1]. So, the growing demand for energy, depletion of fossil fuels and increasing concerns of environmental issues have challenged researchers to develop new technological processes to generate clean and sustainable energy mainly through the utilization of renewable energy sources [2]. However, miscellaneous countries around the world have made remarkable efforts to find a piece of cogent solution for energy crisis by turning the eyes into renewable energy sources such as solar energy, energy produced from wind and water. As an upshot of these efforts, one of the latterly proposed alternative energy sources is Microbial Fuel Cell (MFC) [3]. MFC uses from active microorganisms as a biocatalyst in an anaerobic anode compartment for production of bioelectricity [3, 4]. Although electrical current produced by bacteria was observed by Potter in 1911, limited feasible results were acquired in this area by the next 50 years. However, in the early 1990, Fuel Cells (FCs) became far more appealing devices; consequently, MFCs were considered as promising technology [5]. Furthermore, research domain of MFCs turned much vaster in 1999 once it was discovered that mediator was not a compulsory component within MFCs [6].

Approximately all MFCs consist of anode and cathode chambers, physically separated by a proton exchange membrane (PEM). In general, MFCs are devices that use bacteria as the catalysts to oxidize organic and inorganic matter and generate current [1]. Electrons produced by the bacteria from these substrates are transferred to the anode (negative terminal) and flow to the cathode (positive terminal) linked by a conductive material containing a resistor, or operated under a load (i.e., producing electricity that runs a device). By convention, a positive current flows from the positive to the negative terminal, a direction opposite to that of electron flow [2]. The device must be capable of having the substrate oxidized at the anode replenished, either continuously or intermittently; otherwise, the system is considered to be a biobattery. Electrons can be transferred to the anode by electron mediators or shuttles, by direct membrane associated electron transfer, by so-called nanowires produced by the bacteria, or perhaps by other as yet undiscovered means [7].

MFCs function can be affected by numerous factors such as electrode materials, the electrode surface area, the distance between the electrodes, the reactor configuration, type of proton exchange membrane, temperature, etc. But it can be said the most important factor affecting on performance of MFCs is the number of electrons producing bacteria in the anode chamber. So that the further number of bacteria in the anode chamber cause further decomposition of organic matter and therefore more electron and proton would be released [2, 8].

Most MFC_s in order to optimize the conditions for bacterial growth are operated in a neutral pH. However, the low concentration of protons in this pH increases internal resistance compared to chemical fuel cells used acidic electrolyte [6].

In series-connected MFCs, the individual voltages of each cell add-up at the output while a common current flows through the fuel cells. This association can overcome the limitation with respect to the threshold voltage of transistors. However, in the serial connection, fuel starvation, the absence of bacterial activity in cells and dispersions between the associated MFCs are reasons that cause the voltage reversal phenomenon, what limits the net efficiency of the stack. The series connection of MFCs offers advantages if the reversal phenomenon is corrected [9].

The technology of microbial fuel cell is facing to some restrictions for wastewater treatment because the process have not yet a commercial aspect. Therefore, it is suggested to be addressed in future studies in industrial aspects and using this process as an economic and affordable process in municipal and industrial wastewater treatment.

Acknowledgements

This Article Is a Part of a Research Project (Code: IR.SSU.SPH.REC.1395.35) Approved in Shahid Sadoughi University of Medical Sciences.

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